Researchers of the Lost Pigments:

A multi-disciplinary student-developed **teaching resource** to support **Chemistry** students by using genuine **Archaeological** research

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Overview

- **BSc Project**:
  - Student co-creation (**Craig Sproul**)
  - Cross-discipline collaboration (**Dr Louisa Campbell** – Archaeology)
- **Aim of Project**:
  - Develop, Trial & Assess: an ***outreach teaching resource*** aimed to support final-year secondary school pupils (AH CHEM) linked to SQA curriculum
- **Design of Project**:
  - Project created using scaffolding of **POGIL** (read description in abstract for info), **gamification** and some **object-based learning**
- **Theme of Project**:
  - *Archaeology & Chemistry*: Role of analytical chemistry in the detection and analysis of traces of historic Roman pigments found on Roman sculptures in the UK. Capture interest by underpinning chemistry techniques with genuine application in other fields

Roman Pigment Identification – Dr Louisa Campbell

- **Local UK Interest:** Hadrian's Wall (122AD) & the Antonine Wall **(**142AD)
- **RAMAN and XRF:** Identification of traces of historic **Roman Pigments**
  - Re-imagine how objects originally appeared – eg **Distance Stones** on Antonine Wall
- This genuine **research** captures the imagination and these **analytical techniques** underpin this outreach teaching resource

POGIL in Action

- Two **POGIL** (**P**rocess **O**rientated **G**uided **I**nquiry **L**earning) exercises were designed around **Raman** and **XRF** analytical methods
  - Exercises involve facilitated, sequential, constructivist student-led learning approaches

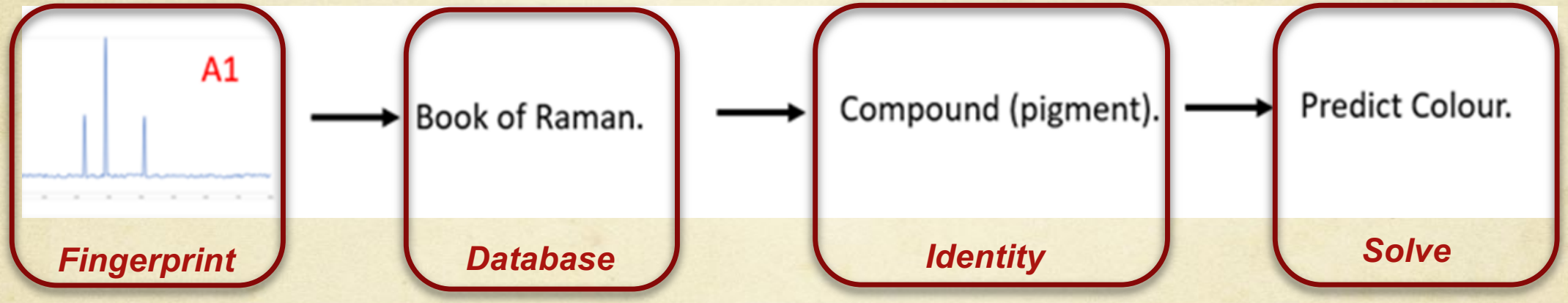
Overview of the Raman POGIL exercise

- **Small groups** (3 students max)
  - Each group works to identify which stone corresponds to their “unique” set of information
  - Each group is given a “unique” set of RAMAN spectra, in sequence
- The groups are **guided** through the task, **step-by-step**, to reach the **correct deduction**

Steps 1 & 2

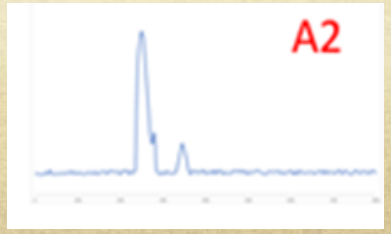
Step 1:

- Groups are given a Raman spectrum of an unknown pigment (**on acetate**)
- The spectrum is matched to one in “The Book of Raman” resource manual
- From this and the included *table of information*, the **pigment is identified** as well as its **chemical composition** and **its colour**.



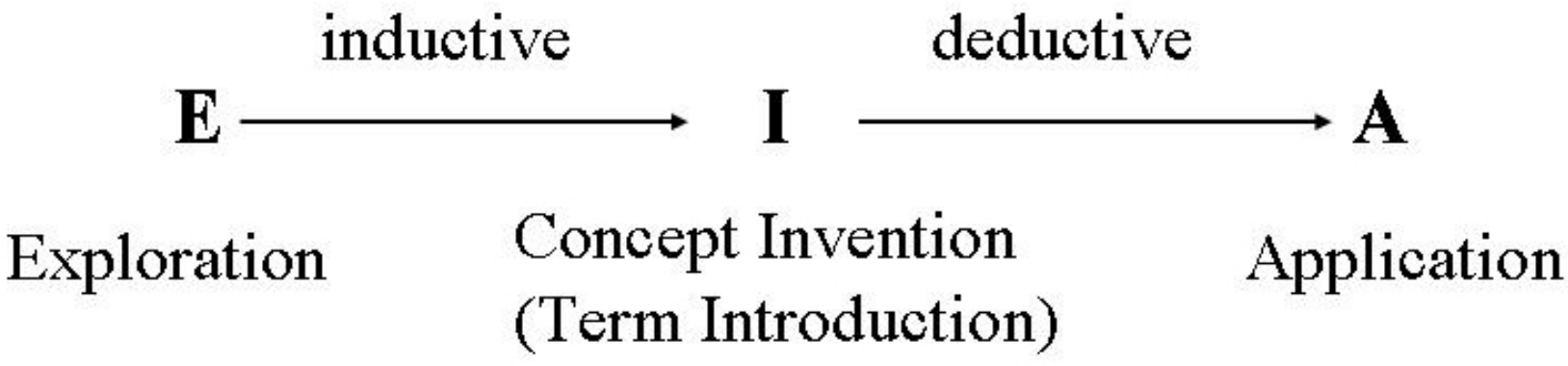
Step 2:

- The same procedure is repeated with a new Raman spectrum



Reasoning – Steps 1 & 2

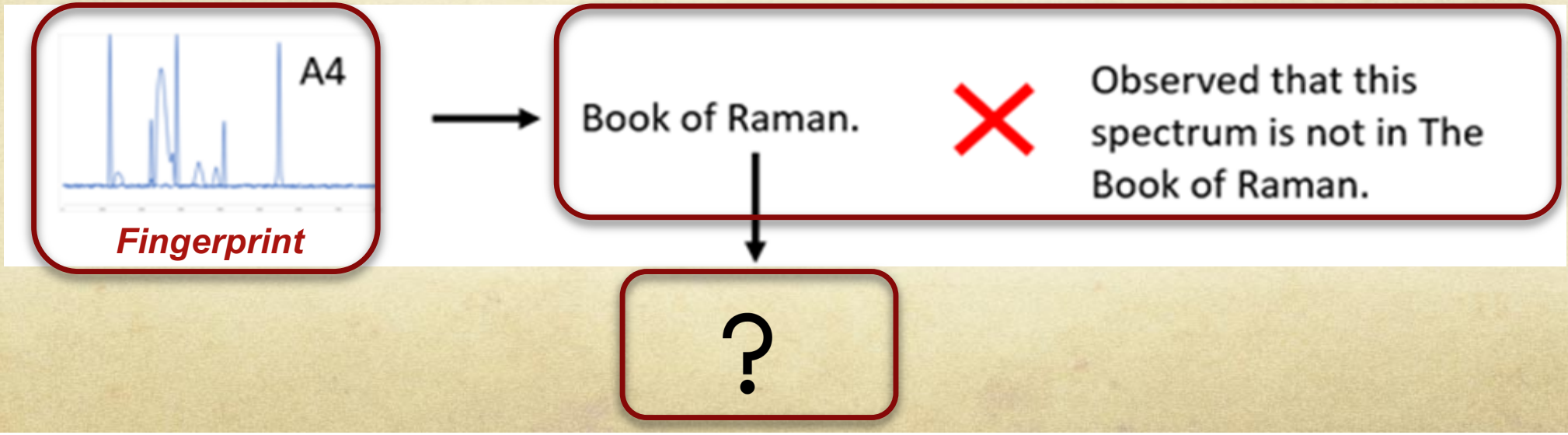
- **Steps 1 & 2** both involve **processes** that the pupils must go through in order to develop their own **concepts** and **ideas** which is a major part of POGIL.



- **Step 1** is repeated in **Step 2** to allow the pupils to **build up confidence** and allow them to **teach them each other** rather than have a lecture.

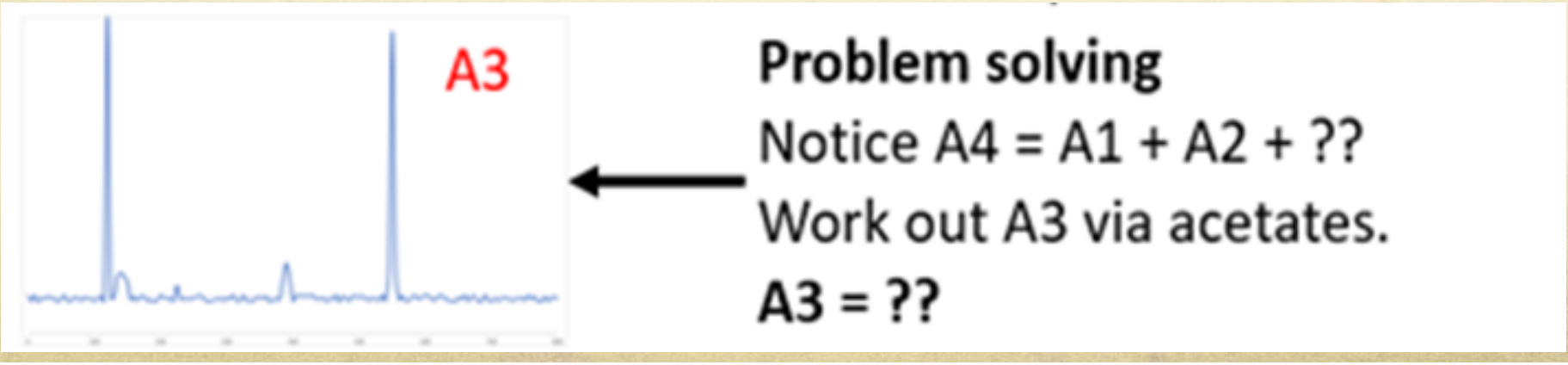
Step 3

- As for **Steps 1 & 2**, Groups are given a spectrum of an unknown pigment.
  - This spectrum is much “messier” and “complicated looking”
- Pupils then follow the same procedure as before but soon realise the new spectrum does NOT match any in the Book of Raman.
- **What to do?**



Step 4

- **How to solve the "complicated" spectrum?**
- Pupils are given a blank acetate and a pen (as a hint)
- **Observation & Deduction:** that this is a combination of three spectra (pigments).
- **Problem Solving**: which allows them to trace out the third unknown pigment (by overlaying first two known spectra) in a retro-analytical approach.
- Using this, and "The Book of Raman", the third pigment, and its colour, is identified.



Reasoning - Steps 3 & 4

- A major part of POGIL is to develop **higher order critical thinking** by applying the previously learnt ideas to new concepts.
- The **team work** and **communication skills** of the groups is also improved as these steps require:
  - **discussion** and **reasoning**
- These are secondary aims of POGIL.

Step 5 – Solving the Mystery & Confirmation

- By combining the colours of the **three** identified pigments, each group **predicts the colour** of their unique "mystery" **PIGMENT MIXTURE**.
- **Identification** of the deduced **painted stone** is marked with name pebble
  - By placing their name pebble next to it, **Closure of Challenge**
- The **deductions are re-confirmed** and **discussed** as a class

Acetates

A4 = A1 + A2 + A3

Predict the colour of the mix.

Groups identify colour of rock they have.

Pilot & Feedback

- Teaching Unit **Trialled** with 38 pupils and feedback was very **positive**
- In the context of POGIL the main **STUDENT** outcomes were as follows.
  - Learned completely **new area** of Chemistry (37/38 students)
  - Improvement of **problem-solving skills** (28/38) and
  - Improvement of **communication skills** (28/38) as a result of the exercise.
  - **Enjoyed** the session (12/13 groups)
- **TEACHER** Feedback also very positive.
  - Greatly supported AH Chemistry curriculum, with positive implications for the exam...(unfortunately, not tested this year)

Past, Present, Future

- Shown success of using POGIL to develop teaching units, eg *analytical chemistry*:
  - **Inorganic** Chemistry (**Roman Pigments**, 2019-20)(RAMAN & XRF cf IR & elemental)
  - **Organic** Chemistry (**Mauveine**, 2018-19)(MS, IR, NMR, Elemental analysis)
- Applicability of the POGIL approach for *other disciplines* in creation of teaching units
- Highlight intention to provide these teaching units, with all resources (videos, teacher packs, student pack, guidelines), so that teachers feel supported and confident in running them independently.
- Power of *student co-creation* of projects – **Thank you Craig Sproul**!
- Successful *cross-disciplinary* collaboration- **Thank you Dr Louisa Campbell**!
- **Thanks to** the **vVICEPHEC Conference Organisers** for their support in bringing this all together under exceptionally difficult circumstances

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References

- Farrell, J.J.; Moog, R.S.; Spencer, J.N. *J. Chem. Educ.* **1999**, 75, 570-574.
- Moog, R.S.; Spencer, J.N. *Process Oriented Guided Inquiry Learning (POGIL)*
- https://pogil.org
- Bloom, B.S.; Englehart, M.D.; Furst, E.J.;Hill, W.H.; Krathwohl, D.R. *Taxonomy of Educational Objectives: Classification of Educational Goals, I. Cognitive Domain*; David McKay Company: New York, **1956.**
- Abraham, M.R. *Inquiry and the Learning Cycle Approach. Chemists' Guide to Effective Teaching*; Pienta, N.J.; Cooper, M.M.; Greenbow, T.J./ Eds.; Pearson-Prentice Hall: N.J, **2005**; pp 41-52
- Kapp, K. M. *The gamification of learning and instruction: Game-based methods and strategies for training and education.* Pfeiffer, **2012**
- Campbell, L.; *Vibrant colours on the Antonine Wall Distance Stones; a new methodology for identifying pigments on Roman sculpture*, Britannia, **2020**.
- Iuliano, A.; Soler, L.; Quye, A.; *Chemistry for Cultural Heritage: Mauveine*, Let's Talk about [X], **2019**.
- Sproul, C.; Soler, L.; Campbell ,L.; *Using Roman History to Teach Heritage Science & Chemistry,* Let's Talk about [X], **2020**.

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